

Colorado Air Toxics Inventory Improvements  
for the National Toxics Inventory

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## **I. Introduction**

The EPA 1996 National Toxics Inventory (NTI) and National Emissions Trends (NET) Inventories for area and mobile sources were based primarily on a top down approach. The huge scope of the NTI project made this necessary because inventories built from the bottom-up are far more labor intensive. Where area source information was lacking (all states needed at least some area source data supplementation), the EPA used information from federal agencies and developed surrogate data often based on population assumptions. Mobile and area source emission estimates were then allocated at a state-level resolution.

States could improve these top down inventories by using information often available in their own agency or sister agencies. The top down approach can lead to poor characterization of emissions due to double counting of sources, elimination of sources, or misallocation of sources.

In the 1996 NTI inventory for Colorado, more than 95% of the non-point source emissions were attributed to four categories of sources: wildfires, highway vehicles, non-road engines, and prescribed burning. These four categories and point source double counting will be the focus of this paper and Colorado's (1999) mobile and area source inventory effort. One other category to be improved is residential wood burning. Previous Colorado inventories for criteria pollutants such as PM10 and carbon monoxide, which are based on local wood burning surveys, have shown much higher wood burning rates than those assumed for the 1996 NTI. The APCD will also attempt to reconcile differences in emission factors used in the NTI and those used for other EPA databases, such as AP-42 and Speciate.

It is anticipated certain methodology improvements used to build the 1999 Colorado HAP inventory will result in significantly different and more accurate air toxics emissions estimates for that year, and ultimately in the modeled ambient air toxics estimates produced for the 1999 National Air Toxics Assessment.

## **II. Background**

Highway vehicle emissions were calculated using vehicle miles traveled (VMT) data from the Federal Highway Administration's Highway Performance Management System (HPMS). Resolution of HPMS data for most geographical areas is at the state level. Even for large urban areas HPMS data are often aggregated; several counties may be included in one area. The EPA process then apportioned the VMT to the county level based on population.

This differs from the bottom-up, roadway-specific information available from most regional councils of government. Much more accurate estimates are available at the state and regional levels. For example,

the Colorado Department of Transportation (CDOT) publishes traffic counts, upon which the HPMS estimates are based, on a roadway segment basis (sub-county). They also publish the entire roadway network in a geographic information system (GIS) format. The CDOT data provides a much better basis for apportioning VMT to a county- or sub-county level than using a population surrogate. In the major urban areas, the Metropolitan Planning Organizations (MPOs) base VMT estimates on a link-based traffic demand model. The estimates are calibrated by traffic counts, providing an even better estimate of VMT.

The NTI double counted some point sources with area sources. Some states, including Colorado, capture nearly all stationary sources in major urban areas in their point source inventories. In Colorado, roughly 380 hazardous air pollutants must be reported at actual levels as low as 50 pounds per year, depending upon toxicity and facility/fenceline characteristics. This is in contrast to the NTI, for which it is assumed that only major source facilities—those emitting more than 10 tons per year of any one HAP, or more than 25 tons per year of any two or more HAP—are captured in point source emission inventories.

Because most states have not included small sources in point source inventories, the EPA assumed that smaller sources, such as gas stations and dry cleaners, were not counted in the point source inventory. Instead a per-capita-type factor was used to generate such emissions. In the QA period for the 1996 NTI, it was noted that several facilities' emissions were double-counted. Additionally, several area source facility types were assumed to exist in all states, when in fact some did not exist in Colorado. These were corrected in the official 1996 NTI.

### III. Anticipated Improvements

#### A. Area/Point Sources

When considering the potential for point source double counting, , the NTI lists 71 categories of area sources. Table I shows total emissions of EPA Urban Source Strategy Hazardous Air Pollutants (Urban HAPs) for area sources.

**Table I:** Colorado 1996 NTI Area Sources

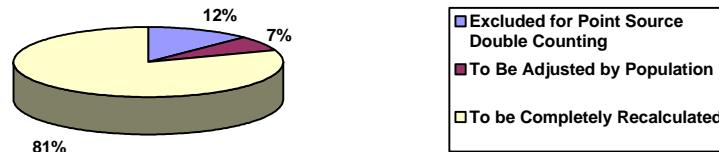
| Category Name  | Total Urban HAPs (tons per year) |
|--|----------------------------------|
| Animal Cremation                                     | 0.001                            |
| Asphalt Concrete Manufacturing                       | 0.014                            |
| Asphalt Roofing Manufacturing                        | 0.109                            |
| Autobody Refinishing Paint Application               | 0.805                            |
| Aviation Gasoline Distribution: Stage I & II         | 0.002                            |
| Cement, Hydraulic                                    | 0.003                            |
| Chemicals and Allied Products, nec                   | 0.320                            |
| Chromic Acid Anodizing                               | 0.020                            |
| Commercial Sterilization Facilities (Ethylene Oxide) | 3.800                            |
| Consumer Products Usage                              | 432.581                          |
| Correctional Institutions                            | 5.150                            |
| Decorative Chromium Electroplating                   | 0.001                            |
| Dental Preparation and Use                           | 0.013                            |
| Electronic Components, nec                           | 0.005                            |
| Fabricated Metal Products, nec                       | 0.005                            |
| Fabricated Structural Metal Manufacturing            | 0.120                            |
| Flexible Polyurethane Foam Fabrication               | 49.960                           |
| Flexible Polyurethane Foam Production                | 30.850                           |
| Gasoline Distribution Stage I                        | 91.433                           |
| Gasoline Distribution Stage II                       | 12.138                           |
| General Laboratory Activities                        | 0.009                            |
| Halogenated Solvent Cleaners                         | 331.219                          |
| Hard Chromium Electroplating                         | 0.750                            |
| Hospital Sterilizers                                 | 11.300                           |
| Human Cremation                                      | 0.012                            |
| Industrial Boilers: Distillate Oil                   | 0.069                            |
| Industrial Boilers: Natural Gas                      | 0.918                            |
| Industrial Boilers: Residual Oil                     | 1.419                            |
| Industrial Boilers: Waste Oil                        | 0.123                            |
| Industrial Boilers: Wood/Wood Residue                | 0.556                            |
| Industrial Inorganic Chemical Manufacturing          | 0.020                            |
| Institutional/Commercial Heating: Distillate Oil     | 1.088                            |
| Institutional/Commercial Heating: Natural Gas        | 1.906                            |

|  |           |
|--|-----------|
| Institutional/Commercial Heating: Residual Oil       | 0.999     |
| Institutional/Commercial Heating: Wood/Wood Residue  | 6.614     |
| Lamp Breakage  | 0.017     |
| Metal Stampings Manufacturing                        | 4.600     |
| Miscellaneous Organic Chemical Processes             | 0.521     |
| Municipal Landfills                                  | 184.615   |
| Natural Gas Transmissions and Storage                | 7.080     |
| Nonferrous Foundries, nec                            | 0.003     |
| Oil and Gas Field Machinery Manufacturing            | 0.373     |
| Oil and Natural Gas Production                       | 238.030   |
| Open Burning: Forest and Wildfires                   | 5,117.700 |
| Open Burning: Prescribed Burning                     | 1,051.158 |
| Open Burning: Scrap Tires                            | 1.898     |
| Paint Stripping Operations                           | 265.720   |
| Perchloroethylene Dry Cleaning                       | 254.260   |
| Pesticide Application                                | 0.004     |
| Pharmaceuticals Production                           | 1.310     |
| Polyvinyl Chloride and Copolymers Production         | 0.086     |
| Primary Batteries, Dry and Wet, Manufacturing        | 0.010     |
| Publicly Owned Treatment Works (POTWs)               | 27.913    |
| Pumps and Pumping Equipment Manufacturing            | 0.005     |
| Railroad Equipment Manufacturing                     | 0.750     |
| Refractories Manufacturing                           | 0.036     |
| Residential Heating: Anthracite Coal                 | 0.022     |
| Residential Heating: Bituminous and Lignite Coal     | 0.058     |
| Residential Heating: Distillate Oil                  | 1.853     |
| Residential Heating: Natural Gas                     | 2.653     |
| Residential Heating: Wood/Wood Residue               | 10.296    |
| Service Industry Machinery                           | 0.040     |
| Softwood Drying Kilns                                | 0.383     |
| Special Industry Machinery, nec                      | 0.005     |
| Stationary Internal Combustion Engines - Diesel      | 0.070     |
| Stationary Internal Combustion Engines - Natural Gas | 1.809     |
| Stationary Turbines                                  | 4.788     |
| Structure Fires                                      | 25.525    |
| Surface Coatings: Architectural                      | 150.778   |
| Surface Coatings: Traffic Markings                   | 0.083     |
| Telephone and Telegraph Apparatus                    | 0.001     |
| TOTAL ALL SOURCES                                    | 8,338.781 |

With the exception of Consumer Products Usage, Dental Preparation and Use, Open Burning, Lamp Breakage, Pesticide Application, Residential Heating, and Surface Coatings, many of the above source categories are likely to be double counted. Because almost all of the stationary source emissions are counted in the Colorado point source inventory, all of the remaining categories will be excluded from the Colorado area source inventory with the exception of Gasoline Distribution Stage I and II, Perchloroethylene Dry Cleaning, and Municipal Landfills. Emissions from these last source categories

can be adjusted for double counting by subtracting the point source emissions in each county from the area source emissions in that county. Municipal Landfill emissions can be adjusted to account for the fact that not all counties have landfills. The excluded area sources, which are accounted for in the

**Figure 1. Colorado 1996 NTI Area Source Adjustments**



Colorado point source inventory, comprise a total of 1,042.1 tons per year of urban HAPs.

Most of the area sources that were not double counted will be adjusted in the 1999 inventory by population growth factors. Categories that will be adjusted for growth include Consumer Products Usage, Dental Preparation and Use, Lamp Breakage, Surface Coatings, Pesticide Application and Residential Heating except Residential Wood Combustion. These categories were estimated to contribute a total of 588 tons per year of urban HAP in the 1996 Colorado NTI inventory. The remaining categories--Residential Wood Combustion, Gasoline Distribution Stage I and II, Perchloroethylene Dry Cleaning, Municipal Landfills and Open Burning: Wild and Prescribed Fire--will be recalculated using VMT and other local data. These categories contributed an estimated 6,709 tons per year of urban HAPs in the 1996 Colorado NTI inventory.

## B. Colorado Residential Wood Combustion

As indicated previously, Residential Wood Combustion emissions have been recalculated for 1999, based on local wood burning surveys and revised emission factors. The emissions in Table II, below, are preliminary, based on emission factors from AP-42 and the Speciate database. Emission estimates from the 1996 Colorado NTI are also shown. Note that emission estimates were not provided for certain HAP in 1996.

**Table II:** Residential Wood Combustion (Tons/Year)

| HAP Name     | Wood burning - Res. |          |
|--------------|---------------------|----------|
|              | 1999 CO             | 1996 NTI |
| Formaldehyde | 285.06              | 3.83     |
| Benzene      | 586.39              |          |
| Lead         |                     | 0.17     |
| Nickel       |                     | 0.01     |
| 7-PAH        | 388.71              |          |
| Manganese    |                     | 6.15     |
| Chromium     |                     | 0.08     |
| Mercury      | 0.10                | 0.00     |
| Arsenic      |                     | 0.04     |
| Cadmium      |                     | 0.01     |

Of note is that emissions of formaldehyde, benzene and 7-PAH are much higher in the Colorado 1999 Inventory than in the 1996 NTI. This is due to the much higher wood burning rates discovered in Colorado survey data and different emission factors. There are no benzene emissions in the 1996 NTI for wood burning, while for the 1999 Inventory, the benzene emission factor from AP-42 was used. Also of note, there are no manganese emissions in the Colorado Inventory because there are no significant values for manganese for wood burning in the Speciate or other EPA databases.

### C. Colorado Wild and Prescribed Fire

The Western Regional Air Partnership is gathering wild and prescribed fire data from the states and land managers. This information will be used to improve emission estimates for this category when it is available.

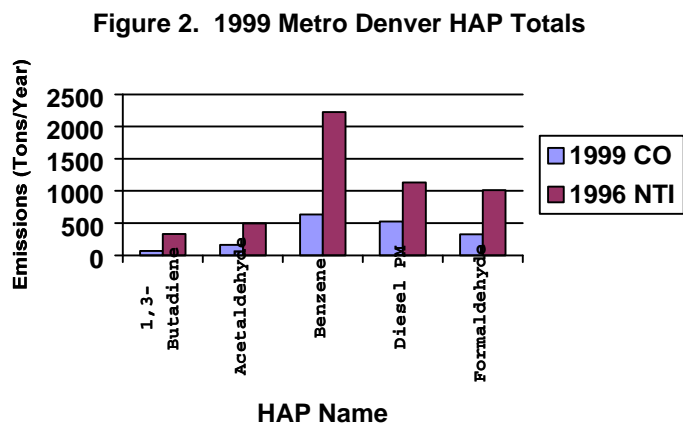
### D. Colorado Highway Vehicles

For the 1999 Inventory highway vehicle emissions were calculated based on vehicle miles traveled (VMT) and the EPA Mobile emission factor model. The 1999 VMT was obtained from the Federal Highway Administration's Highway Performance Management System (HPMS) and is based on the Colorado Department of Transportation (CDOT) published traffic counts. CDOT categorizes traffic data by county into rural and four urban classes based on urban population. Roadway segments (sub-county) and the entire roadway network are published in a geographic information system (GIS) format. For the 1999 Inventory, the Colorado APCD allocated the HPMS VMT data to the census tract level.

For major urban areas on, the APCD generally used VMT estimates provided by the regional councils of government. The estimates are based on a link-based traffic demand model, which are calibrated by traffic counts. These estimates have been used in place of HPMS estimates where they are available.

The on-road mobile source emission factors will be recalculated using the modified version of the MOBILE5b emission factors model, MOBTOX5b, and the modified PART5 model. It is expected that the use of local data for speeds, vehicle mix and VMT will result in significant differences between Colorado emission estimates in the 1996 NTI and those developed for the 1999 Colorado Inventory.

Figure 2 is a summary of highway vehicle HAP emissions for the metropolitan Denver area. As can be





seen, there are major differences in emissions between the 1999 Colorado Inventory and the 1996 Colorado data from the NTI. Table III, below, shows highway vehicle HAP emissions at a county level for the metropolitan Denver area.

**Table III:** 1999 Highway Vehicle Metro Denver HAP Emissions (Tons/Year)

| HAP Name      |          | ADAMS | ARAPAHOE | BOULDER | DENVER | DOUGLAS | JEFFERSON | TOTAL   |
|---------------|----------|-------|----------|---------|--------|---------|-----------|---------|
| 1,3-Butadiene | 1999 CO  | 10.5  | 12.0     | 6.1     | 17.6   | 6.6     | 14.1      | 66.8    |
|               | 1996 NTI | 47.8  | 71.1     | 34.2    | 81.4   | 15.3    | 85.5      | 335.2   |
| Acetaldehyde  | 1999 CO  | 25.5  | 28.3     | 14.7    | 41.9   | 16.6    | 33.9      | 161.0   |
|               | 1996 NTI | 70.3  | 102.9    | 53.9    | 115.9  | 26.1    | 127.8     | 496.9   |
| Benzene       | 1999 CO  | 98.5  | 116.4    | 57.5    | 169.9  | 58.4    | 135.0     | 635.6   |
|               | 1996 NTI | 318.4 | 476.5    | 222.3   | 548.6  | 95.7    | 566.0     | 2,227.4 |
| Diesel PM     | 1999 CO  | 95.1  | 75.3     | 49.6    | 115.5  | 78.6    | 111.9     | 526.1   |
|               | 1996 NTI | 157.5 | 222.6    | 137.5   | 241.4  | 76.4    | 296.9     | 1,132.4 |
| Formaldehyde  | 1999 CO  | 52.9  | 56.9     | 30.2    | 85.1   | 35.7    | 69.1      | 330.0   |
|               | 1996 NTI | 142.9 | 207.3    | 113.7   | 231.3  | 57.4    | 262.4     | 1,014.9 |

The 1999 Inventory is based on VMT from the Denver Regional Council of Governments (DRCOG). The VMT are link-based from the DRCOG travel demand model. Different vehicle mixes (the percent of VMT from each vehicle class such as cars or heavy-duty diesel trucks) were used for each facility type (freeway, major arterial, etc.) and area type (CBD, suburban, rural, etc.).

The 1996 NTI highway vehicle inventory used only four different temperatures, one speed (19.6 mph) and one vehicle mix. Average benzene emissions ranged from 54.9 to 67.0 milligrams per mile (mg/m) in the NTI. The 1999 Colorado highway vehicle inventory used 1,138 combinations of speed, vehicle mix and temperature. Average benzene emissions ranged from 11.1 to 141.7 mg/m in the Colorado 1999 inventory. It is not surprising that there are major differences in HAP emissions between the 1999 and 1996 inventories.

A comparison of the 1996 NTI with 1996 and 1999 Colorado calculated highway diesel emissions for Denver County is shown in Table IV.

**Table IV:** Comparison of Metro Denver Highway  
Diesel Emissions In 1996 (Tons/Year)

| County    | 1996 NTI | CO 1996 | CO 1999 |
|-----------|----------|---------|---------|
| ADAMS     | 157.5    | 85.8    | 95.1    |
| ARAPAHOE  | 222.6    | 66.4    | 75.3    |
| BOULDER   | 137.5    | 46.2    | 49.6    |
| DENVER    | 241.4    | 112.8   | 115.5   |
| DOUGLAS   | 76.4     | 68.1    | 78.6    |
| JEFFERSON | 296.9    | 110.7   | 111.9   |
| TOTAL     | 1,132.4  | 490.0   | 526.1   |

The differences in emissions between 1999 and the 1996 NTI are mainly due to differences in the VMT and the vehicle mix (percent of diesel vehicles). The NTI used one vehicle mix with 6.5% heavy-duty diesel vehicles. The Colorado inventory used 46 different vehicle mixes, and the heavy-duty diesel vehicle mix ranged from 1.8% to 18.8%. The increase in the Colorado Inventory from 1996 to 1999 is due to increased VMT from diesel vehicles.

## E. Colorado Non-Road Engines

Emissions from non-road mobile sources (such as lawn mowers and forklifts) were calculated using the EPA Non-road Emission Factor Model. The default allocation tables used to apportion emissions to the county level were modified for some source categories based on new surrogates for 1999.

Table V, below, is a summary of the non-road allocation factors. The surrogate allocation data were used to apportion non-road sources by census tract.

**Table v. NONROAD surrogate allocation factors**

| Category/Type                                    | Non-road Model Allocation   | New Allocation Factor  |
|--|---|--|
| Lawn and Garden Residential                      | Number of single and double (duplex) family housing units from 1990 Adjusted by 1997 Census by county.  | Same   |
| Lawn and Garden Commercial                       | Number of employees in landscape and horticultural services, County Bus. Patterns (CBP), Standard Industrial Code (SIC)78.  | Apportioned to census tracts by number of single and double (duplex) family housing units from 1990 Adjusted by 1997 Census by county. |
| Residential Snowblowers                          | Same as residential lawn and garden, adjusted by annual average snowfall.   | Same   |
| Commercial Snowblowers                           | Same as commercial lawn and garden, adjusted by annual average snowfall.  | Same   |
| Construction                                     | Total dollar value of construction by county.   | Population   |
| Agricultural                                     | Harvested cropland (U.S. Census Bureau, <u>USA Counties</u> database).  | Apportioned to census tracts by area of private land in tracts with less than 200 people per square mile.                              |
| Recreational (except snowmobiles and golf carts) | Number of camps and recreational vehicle park establishments (CBP SIC 7030).  | Public land area available for recreational vehicle use.   |
| Snowmobiles                                      | State level populations from registration data compiled by the International Snowmobile Manufacturers Association, then allocated to counties using same factors as other recreational equipment. | Same   |
| Golf Carts                                       | Number of public golf course employees (CBP SIC 7992).  | Same   |
| Aircraft Ground Support Equipment                | Number of landings and takeoffs (LTOs) of commercial aircraft   | Same   |
| Light Commercial                                 | Number of wholesale establishments (CBP SIC 50).  | Total emissions by SIC   |
| Industrial                                       | Number of employees in manufacturing (CBP SIC 20)   | Total emissions by SIC   |
| Logging  | Number of employees in logging plus saw and planing mills (CBP SIC 2410 and 2420).  | Total emissions by SIC   |
| Oil Field Equipment                              | Number of employees engaged in oil and gas extraction (CBP SIC 1300).   | Total emissions by SIC   |
| Railroad Maintenance Equipment                   | 1990 Human Population   | Miles of rail  |
| Underground Mining Equipment                     | Number of employees Coal Mining (CBP SIC 1200).   | Total emissions by SIC   |

For example, allocation of light commercial emissions in the Colorado implementation of the Non-road Model is based on the amount and location of stationary emissions from commercial SIC code sources in the Colorado Point Source Inventory. This is more accurate than using wholesale establishment employment from the census because the Point Source Inventory captures a broader range of commercial activity than just wholesale. Allocation of industrial non-road emissions for the 1996 NTI was based on the number of employees in manufacturing. Again, the Colorado Point Source Inventory was used to allocate non-road emissions for the industrial category by using emissions from related SIC codes in the industrial sector. These emissions are thought to be better indications of non-road engine use than employment in a single SIC code.

Table VI, below, is a summary of non-road diesel particulate emissions for selected counties and the State.

**Table VI. Non-Road Diesel PM (Tons/Year)**

| Category           | Denver  |          | Rio Blanco |          | Kit Carson |          | State    |          |
|--------------------|---------|----------|------------|----------|------------|----------|----------|----------|
|                    | 1999 CO | 1996 NTI | 1999 CO    | 1996 NTI | 1999 CO    | 1996 NTI | 1999 CO  | 1996 NTI |
| Agricultural       | 8.64    | 0.00     | 5.06       | 6.53     | 75.94      | 98.13    | 958.87   | 1,239.04 |
| Airport GSE        | 15.33   | 24.19    | 0.00       | 0.00     | 0.00       | 0.00     | 18.67    | 30.08    |
| Boats              | 0.00    | 0.01     | 0.05       | 0.01     | 0.00       | 0.00     | 3.67     | 2.42     |
| Commercial         | 24.91   | 56.14    | 0.03       | 0.27     | 5.59       | 0.92     | 254.10   | 225.86   |
| Construction       | 411.01  | 439.87   | 5.10       | 1.44     | 6.09       | 13.48    | 3,335.76 | 3,777.40 |
| Industrial         | 20.52   | 65.70    | 0.00       | 0.42     | 3.52       | 0.54     | 426.60   | 448.16   |
| Lawn and Garden    | 36.80   | 10.86    | 0.00       | 0.00     | 0.00       | 1.13     | 280.89   | 260.54   |
| Logging            | 0.00    | 3.46     | 0.00       | 0.00     | 0.00       | 0.05     | 14.37    | 20.32    |
| Oil Field          | 0.00    | 23.28    | 0.72       | 0.00     | 1.20       | 0.00     | 35.18    | 39.43    |
| Rail Service Equip | 0.11    | 1.14     | 0.00       | 0.01     | 0.15       | 0.02     | 7.99     | 8.75     |
| Recreation         | 0.00    | 0.00     | 1.45       | 0.00     | 0.00       | 0.00     | 19.81    | 16.69    |
| Underground Mining | 0.00    | 23.91    | 25.06      | 0.00     | 0.00       | 0.00     | 81.81    | 69.19    |
| TOTAL              | 517.33  | 648.56   | 37.47      | 8.69     | 93.30      | 114.27   | 5,437.71 | 6,137.87 |

There are major differences in county emissions between the Colorado Inventory and the 1996 NTI; but State total emissions are comparable. The differences in emissions between the two inventories at a State level are primarily due to growth, and differences in input parameters to the Non-Road Model such as temperature and gasoline Reid vapor pressure. Table VII compares 1999 highway and non-road diesel particulate emissions for the Denver metropolitan area.

**Table VII.** 1999 Metro-Denver

Highway and Non-Road Diesel PM

(Tons/Year)

| County    | Highway | Non-Road |
|-----------|---------|----------|
| ADAMS     | 95.1    | 422.74   |
| ARAPAHOE  | 75.3    | 505.99   |
| BOULDER   | 49.6    | 327.73   |
| DENVER    | 115.5   | 517.33   |
| DOUGLAS   | 78.6    | 173.01   |
| JEFFERSON | 111.9   | 493.32   |
| TOTAL     | 526.1   | 2,440.11 |

The Colorado Air Pollution Control Division (APCD) is concerned that non-road emissions are over-estimated, in light of the reductions that the use of local data has made in the highway vehicle category. However, we do not have detailed activity data, such as the number and hours of usage of non-road engines, or the number of emission units with which to correct these emissions. The development of better activity data for major non-road categories, such as construction, is needed at a national level, along with surrogates to adjust this activity to a state and local level.

#### **IV. CONCLUSIONS**

The NTI is a good starting point for developing a state or local inventory, but the use of local data can result in major improvements. This is especially true in the highway vehicle and non-road categories. The APCD will continue to refine its statewide air toxics inventory for 1999 (and for 1996 in areas of special interest).